

December 2014

EB 2014-12



Manure Application Cost Study

New York State

Spring 2012



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The Manure Application Cost Study was funded in part by



This work was supported in part by Hatch and Smith Lever funding provided by the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the National Institute of Food and Agriculture (NIFA) or the United States Department of Agriculture(USDA).

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Manure Application Cost Study

B. Howland¹ and J. Karszes¹

The collection, storage, and application of liquid manure are important activities taking place on farms every year. These activities require ever increasing levels of investment and management. Increasing farm size, bedding availability, environmental regulations, and nutrient management plans have led more farms to utilize liquid manure systems. The manner in which these activities are structured and managed can impact the profitability of the dairy farm through many different avenues. One important aspect of the manure management system is the cost to apply manure.

The purpose of this study is to identify the costs associated with using tankers to transport and apply liquid manure, while developing a template that can be used to collect, summarize, and analyze costs for any manure application system. By knowing the costs associated with application of liquid manure through transporting and spreading with tankers, one can better understand the impact that the total manure system has on the farm.

Study Methodology

Analyzing costs associated with spreading manure using actual farm records has been difficult because few farms have kept records detailed enough to look back over a period of time and identify costs by different activities on the farm. They haven't identified costs directly associated with the application of manure.

To estimate the costs to haul and spread liquid manure using tankers, surveys were used by 27 participating farms to collect information concerning the inputs and investments used within their manure application program. This data set is not designed to represent the average cost for spreading of manure on farms in New York. It is a descriptive study of what costs are for the participating farms that utilize tankers to transport and spread manure.

To complete the survey for manure applied in the spring of 2012, farmers used a combination of approaches. They tracked labor hours, fuel usage, and amount of manure applied by day and location for a period of time lasting from a week up to a month. They also analyzed their past financial records for costs associated with manure application that may not have been incurred

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during the time frame being tracked along with the original investment levels for the machinery.

This information was collected for all machinery being utilized for manure application. Costs were calculated for each piece of equipment for the time period tracked. Combining all equipment being utilized determined the total cost for the time frame, which was then divided by the gallons of liquid manure applied to determine the cost per 1,000 gallons. Costs were also calculated on per load and per acre basis.

Costs were not determined based on the amounts of nitrogen, potassium, or phosphorous in the manure that was hauled. Costs of application are related to the weight and volume of the liquid manure, and the percent of N, P, & K associated with the manure has very little impact on these two factors. Storage systems, treatment costs, and value of nutrients applied to fields are additional areas of importance associated with the overall manure management program on farms.

Since the focus of this study was to determine what the costs were for the participating farms using their actual input costs, no attempt was made to standardize input values across farms. The only measure standardized across all farms was the opportunity cost of capital on the farm, at 7 percent.

Total Cost of Manure Application

Farm Demographics

Twenty-seven farms from across New York State participated in the Cost of Manure Application Study. These farms spread manure using tankers in one of two methods; either loading on a spreader at manure pit and applying directly to fields using the same equipment or loading a tanker at the manure pit and then transferring the load to a spreader at the field for application. This study captured a period of time for manure hauling on farms. The farms provided an estimate of the total liquid manure they would apply over the year.

The 27 farms averaged 840 milking cows with an 80th percentile range from 256 to 1246 cows (Table 1). Farms estimated that they spread an average of 9,639,825 gallons of liquid manure annually with a range from 3,924,000 to 16,000,000 gallons. This study captured on average 26% of the estimated annual manure spread for these 27 farms. The number of gallons spread during the study period for these farms averaged 2,237,820 with an 80th percentile range from 381,960 to 4,788,180 gallons. Farms had an average capacity to apply 234,473 gallons of manure in a ten hour day with a range from 57,541 gallons to 424,401 gallons (Table 2). This represented about

three percent of the estimated total liquid manure these farms spread in a year with an 80th percentile range from 0.8 percent to 5 percent.

Manure handling equipment represents a significant investment on dairy farms. The 27 farms in the study have invested \$33.86 per 1,000 gallons applied or \$264.63 per cow in manure hauling and spreading equipment associated with liquid manure. There is a \$49 range in investment per 1,000 gallons from \$16.19 to \$65.19. The range in investment per cow is just as broad with a 80th percentile minimum of \$138.80 per cow and maximum of \$442.66 per cow.

The average field size for these farms was 20.26 acres with a range from 10.37 to 42.36. Fields were on average 3.5 miles one way for the farm, with an 80th percentile range of 1 to 8.1 miles. Round trip time per load averaged 34 minutes, ranging from 23.3 to 52.6 minutes. Farms had the ability to cover on average 2.55 acres per operating hour at a rate of 6,293 gallons applied per acre. Tables 1 and 2 include these, and other, descriptive statistics

Table 1

Cost of Manure Application			
Descriptive Statistics			
27 Farms, New York State, Spring 2012			
		80th Percentile Range	
	Average	Min	Max
Acres Covered per Operating Hour of Manure Application	2.55	0.96	4.36
Average Field Size, Acres	20.26	10.37	42.36
Average Number of Cows	840	256	1,246
Estimated Total Manure Gallons for Year	9,639,825	3,924,000	16,000,000
Gallons of Manure Spread per Application Hour	15,081	6,217	24,844
Gallons of Manure Spread per Labor Hour	11,308	5,468	26,860
Gallons of Manure Spread per Acre	6,293	3,929	9,097
Average Distance to Fields, One Way, Miles ¹	3.5	1.0	8.1
Average Travel Time, Round Trip, Minutes ¹	34.0	23.3	52.6
Gallons of Manure Spread per Mature Cow during Study Period	3,037	573	5,960
Estimated Total Gallons of Manure Spread per Mature Cow per Year	11,703	8,979	16,411
Percent of Estimated Annual Manure Analyzed	26%	5%	63%
Cost per Worker Equivalent	\$43,331	\$32,408	\$55,200
Investment in Manure Equipment per 1,000 Gallons	\$33.86	\$16.19	\$65.19
Investment in Manure Equipment per cow	\$264.63	\$138.80	\$442.66
Average Useful Life, Years	22.77	9.79	26.29
Salvage Value, Percent of Original Investment	30%	14%	49%
¹ 25 Farms Reporting Data for Distance and Travel Time			

Table 2

Cost of Manure Application			
Analysis Statistics			
27 Farms, New York State, Spring 2012			
		80th Percentile Range	
	Average	Min	Max
Gallons of Manure Application Capacity in a 10 Hour Day	234,473	57,541	424,401
Manure Application Capacity in a 10 Hour Day as % of Estimated Total Manure for Year	3.0%	0.8%	5.0%
Gallons of Fuel Used per 1,000 Gallons of Manure Spread	0.71	0.23	1.66
Operating Efficiency (Operating Hours/Total Hours)	94.0%	87.0%	99.8%
Labor Hours per 1,000 Gallons of Manure Spread	0.12	0.04	0.18
Total Cost of Manure Application for Study Period	\$25,469	\$3,819	\$57,253
Total Cost of Manure Application per Cow for Study Period	\$38.21	\$5.05	\$73.88
Total Cost of Manure Application per Hundredweight of Milk Produced (cwt.) for Study Period	\$0.15	\$0.02	\$0.34
Estimated Annual Cost of Manure Application	\$105,853	\$28,344	\$201,298
Estimated Annual Cost of Manure Application per Cow	\$134.09	\$79.97	\$230.54
Estimated Annual Cost of Manure Application per Hundredweight of milk produced (cwt.)	\$0.53	\$0.30	\$0.85

Cost per Cow and per Cwt. (hundredweight) of Milk Sold

On average farms applied 3,037 gallons of manure per mature cow during the study period with a range from 573 gallons to 5,960 gallons (Table 1). Farms averaged 840 cows in size with a range from 256 cows to 1,246 cows. Annual milk production averaged 203,152 cwt. with a range from 35,201 to 321,872 cwt. The total cost of manure application per cow during the study period was \$38.21 with a range of almost \$69.00 from \$5.05 to \$73.88 (Table 2). The total cost of manure application per cwt. for the study period averaged \$0.15 with a range from \$0.02 to \$0.34 per cwt. With the study only capturing a portion of the manure applied during the year, farms provided an estimate of the total liquid manure applied for the year. This does not include manure that was spread from bedded packs etc. on the farm. Based on this total manure applied

during the year, the total estimated annual cost of manure application averaged \$0.53 per cwt. with a range from \$0.30 per cwt. to \$0.85 per cwt. Total estimated annual cost of manure application averaged \$134.09 per cow with an range from \$79.97 to \$230.54.

Total Cost per Thousand Gallons Spread

The total cost of liquid manure application was divided into three different types of costs : operating costs, ownership costs and custom service costs. Operating and ownership costs as a total represent the cost of farm activities. Custom service costs are those that are provided by an off- farm company. Table 3 represents the average costs on farms as well as the 80th percentile range. Each cost category is sorted independently and minimum and maximum values in this table are not additive. Costs per 1,000 gallons of manure spread averaged \$11.31 per 1,000 gallons spread with a range of \$9.49, from \$7.36 to \$17.05, per 1,000 gallons spread.

Total operating costs for all 27 farms in the study represent 50 percent of total costs, averaging \$5.63 per 1,000 gallons spread with a range of \$1.96 to \$9.09 per 1,000 gallons, a difference of \$7.13. Operating costs are comprised of labor, fuel and utilities and repair costs. Each of these contributed between 14 and 19 percent of the total costs.

Ownership costs represent 26% of total costs or \$2.94 with a range from \$1.37 to \$4.87 per 1,000 gallons. Ownership costs are made up of depreciation, interest and insurance costs. The total cost of farm activities, both operating and ownership costs, is \$8.58 per 1,000 gallons with a range of \$3.97 to \$12.15. Rounding out the total cost category is custom service costs at 24% of total costs or \$2.73 per 1,000 gallons with a range from \$0.00 to \$9.27. Note that not all farms reported having custom service expenses. Farms with \$0 in custom service costs are applying manure using all farm-owned equipment and labor.

Table 3

Cost of Manure Application					
Total Cost per 1,000 Gallons Spread					
27 Farms, New York State, Spring 2012					
			80th Percentile Range¹		Percent
		Average	Min	Max	of Total
Total Gallons Spread (1,000s)		2,238	382	4,788	
Operating Costs	Labor	\$1.86	\$0.64	\$3.30	16%
	Fuel & Utilities	\$2.17	\$0.74	\$3.56	19%
	Repair	\$1.61	\$0.35	\$2.76	14%
	Total Operating	\$5.63	\$1.96	\$9.09	50%
Ownership Costs	Depreciation	\$1.48	\$0.74	\$2.53	13%
	Interest	\$1.35	\$0.58	\$3.08	12%
	Insurance	\$0.12	\$0.02	\$0.25	1%
	Total Ownership	\$2.94	\$1.37	\$4.87	26%
Total Cost of Farm Activities		\$8.58	\$3.97	\$12.15	76%
Custom Services Costs	Provided Fuel Cost	\$0.31	\$0.00	\$1.55	3%
	Custom Service	\$2.40	\$0.00	\$8.00	21%
	Other Fees	\$0.01	\$0.00	\$0.00	0%
Total Cost of Custom Services		\$2.73	\$0.00	\$9.27	24%
Total Cost, All Activities		\$11.31	\$7.56	\$17.05	

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Cost per Acre Covered

The 27 farms applied manure to an average of 362.7 acres during the study period with an 80th percentile range of 79.9 to 734.9 acres (Table 4). The total cost of applying manure averaged \$69.31 per acre. There was a \$73.65 range in the data from \$36.56 to \$110.21. Total operating costs averaged \$36.63 per acre with a range from \$12.35 to \$74.71. The largest contributor to operating costs per acre was fuel and utilities at 20 percent of total costs or an average of \$14.09 per acre. Total ownership costs were 26 percent of total costs per acre with an average of \$17.95 per acre and a range from \$7.09 to \$33.15 per acre. Cost of farm activities, made up of operating and ownership costs, averaged \$54.57 per acre covered. Custom service costs made up the remaining 21 percent of total costs per acre at an average of \$14.74 per acre with a range from \$0 to \$53.25. Again, farms with \$0 custom service cost utilized all owned equipment and labor to apply manure.

The percentage of total costs for each cost area is different than reported for cost per 1,000 gallons because application rates per acre varied across the farms. Also, some farms used custom services while others did not.

Table 4

Cost of Manure Application					
Total Cost per Acre					
27 Farms, New York State, Spring 2012					
			80 th Percentile Range ¹		Percent
		Average	Min	Max	of Total
Total Acres Covered		362.69	79.94	734.89	
Operating Costs	Labor	\$12.40	\$3.44	\$32.00	18%
	Fuel & Utilities	\$14.09	\$3.66	\$26.24	20%
	Repair	\$10.14	\$2.34	\$16.87	15%
	Total Operating	\$36.63	\$12.35	\$74.71	53%
Ownership Costs	Depreciation	\$9.00	\$2.99	\$16.13	13%
	Interest	\$8.20	\$2.57	\$14.73	12%
	Insurance	\$0.74	\$0.08	\$1.78	1%
	Total Ownership	\$17.95	\$7.09	\$33.15	26%
Total Cost of Farm Activities		\$54.57	\$22.00	\$96.06	79%
Custom Services Costs	Provided Fuel Cost	\$1.55	\$0.00	\$7.50	2%
	Custom Service	\$13.15	\$0.00	\$42.35	19%
	Other Fees	\$0.03	\$0.00	\$0.00	0%
Total Cost of Custom Services		\$14.74	\$0.00	\$53.25	21%
Total Cost, All Activities		\$69.31	\$36.56	\$110.21	

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Costs per Load

On average there were 389 loads of manure spread with an 80th percentile range of 71 to 923 loads (Table 5). Average load size of the spreaders in the study was 5,868.6 gallons with an 80th percentile range of 3,960 gallons to 8,271.6 gallons. The total cost per load spread on these 27 farms was \$67.53 with an 80th percentile spread of \$79.78, from \$35.88 on the low end to \$115.66 on the high end. Total operating costs per load made up 47 percent of total costs at an average of \$31.52 per load and a range from \$12.77 to \$49.67 per load. Ownership costs were 25% of total cost per load, averaging \$16.81 per load with a range from \$5.80 to \$31.46. These two categories are added together to determine the cost of on-farm activities which averaged \$48.33 per load with a range from \$23.23 to \$78.07. Custom service costs averaged \$19.20 per load making up the final 28 percent of the total cost per load.

The percentage of total costs for each area is different than reported for cost per 1,000 gallons and cost per acre because load size varied across the farms and some farms used custom services while others did not.

Table 5

Cost of Manure Application					
Total Cost per Load					
27 Farms, New York State, Spring 2012					
			80th Percentile Range¹		Percent
		Average	Min	Max	of Total
Total Loads Spread		389.36	71.45	922.80	
Operating Costs	Labor	\$10.29	\$4.25	\$18.48	15%
	Fuel & Utilities	\$12.56	\$4.90	\$24.48	19%
	Repair	\$8.67	\$0.08	\$14.14	13%
	Total Operating	\$31.52	\$12.77	\$49.67	47%
Ownership Costs	Depreciation	\$8.48	\$3.34	\$16.36	13%
	Interest	\$7.69	\$2.40	\$14.85	11%
	Insurance	\$0.64	\$0.08	\$1.52	1%
	Total Ownership	\$16.81	\$5.80	\$31.46	25%
Total Cost of Farm Activities		\$48.33	\$23.23	\$78.07	72%
Custom Services Costs	Provided Fuel Cost	\$2.45	\$0.00	\$8.59	4%
	Custom Service	\$16.70	\$0.00	\$61.96	25%
	Other Fees	\$0.05	\$0.00	\$0.00	0%
Total Cost of Custom Services		\$19.20	\$0.00	\$69.32	28%
Total Cost, All Activities		\$67.53	\$35.88	\$115.66	100%

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Cost per 1,000 Gallons for Farms Not Using Custom Services

Table 6 shows the cost of manure application for farms that applied manure not using any custom services. Costs per 1,000 gallons of manure spread averaged \$9.82 with an 80th percentile range of \$4.65, from \$7.52 to \$12.16, per 1,000 gallons spread. Operating and ownership costs as a total represent the cost of farm activities.

Total operating costs for these 16 farms represented 69 percent of total costs, averaging \$6.82 per 1,000 gallons spread with a range of \$5.07 to \$9.29 per 1,000 gallons. Fuel and Utilities were

25% of the total costs whereas labor was 24% and repairs were 20%. Ownership costs represent 31% of total costs or \$3.00 with a range from \$1.61 to \$4.96 per 1,000 gallons. The largest contributors to ownership costs are depreciation and interest costs.

Selected descriptive and analysis statistics are provided for the 16 farms not using custom services in Table 7. Farms that did not use any custom services averaged 943 cows in size and spread on average about 10.5 million gallons of manure a year. During the study period 21.4% of the estimated total manure spread for the year was applied, with a range from 2.44% to 52%. Average field size was 23.77 acres with a range from 10.34 acres to 44.8 acres. The fields were on average 4.22 miles from the manure pit and it took about 33 minutes to make a round trip. These 16 farms applied on average 6,627 gallons of manure per acre. They invested \$31.44 per 1,000 gallons or \$264.95 per cow in manure equipment.

Farms that did not use any custom services had a manure application capacity in a 10 hour day, measured as a percent of estimated total manure for a year, of 2.69% with a range from 0.79% to 4.50%. They had an average operating efficiency of 92%. The estimated annual cost of manure application per cow for these farms was \$109.19 per cow with a \$143.90 range from \$79.54 to \$160.87. The average estimated cost of manure application per cwt. was \$0.44 with a range of \$0.33 to \$0.62.

Of the 27 farms in the study, 11 utilized custom services. Custom haulers were utilized by 8 of the farms, and custom hauling and spreading was utilized by 4 farms. One farm used custom services for both hauling and hauling and spreading. For these 11 farms, custom services cost an average of \$6.69 per 1,000 gallons handled by the custom service providers, representing 50% of the of the total costs to haul and spread manure

Table 6

Cost of Manure Application					
Total Cost per 1,000 Gallons Spread					
Farms Not Using Custom Services					
16 Farms, New York State, Spring 2012					
			80th Percentile Range¹		Percent
		Average	Min	Max	of Total
Total Gallons Spread (1,000s)		2,135	187	4,827	
Operating Costs	Labor	\$2.37	\$1.54	\$3.57	24%
	Fuel & Utilities	\$2.47	\$1.73	\$3.59	25%
	Repair	\$1.98	\$1.19	\$2.92	20%
	Total Operating	\$6.82	\$5.07	\$9.29	69%
Ownership Costs	Depreciation	\$1.46	\$0.75	\$2.61	15%
	Interest	\$1.38	\$0.57	\$2.55	14%
	Insurance	\$0.16	\$0.02	\$0.43	2%
	Total Ownership	\$3.00	\$1.61	\$4.96	31%
Total Cost of Farm Activities		\$9.82	\$7.52	\$12.16	100%
Total Cost of Custom Services		\$0.00	\$0.00	\$0.00	0%
Total Cost, All Activities		\$9.82	\$7.52	\$12.16	

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Table 7

Cost of Manure Application				
Farms Not Using Custom Services				
Selected Descriptive and Analysis Statistics				
16 Farms, New York State, Spring 2012				
			80th Percentile	
		Average	Min	Max
Descriptive Statistics				
Average Number of Cows		943	414	1,498
Total Manure Gallons for Year		10,468,363	3,780,000	17,200,000
Percent of Estimated Total Manure Analyzed		21.40%	2.44%	52.00%
Average Field Size, Acres		23.77	10.34	44.80
Average Distance to Fields, One Way, Miles		4.22	1.90	9.69
Average Travel Time, Round Trip, Minutes		33.21	23.31	48.41
Average Travel Time per Mile, Minutes		3.87	1.77	7.77
Gallons of Manure Spread per Acre		6,627	4,128	10,389
Cost per Worker Equivalent		\$44,496	\$34,484	\$55,200
Investment in Manure Equipment per 1,000 Gallons		\$31.44	\$13.60	\$60.47
Investment in Manure Equipment per Cow		\$264.95	\$133.69	\$442.57
Analysis Statistics				
Manure Application Capacity in a 10 Hour Day as % of Total Manure for Year		2.69%	0.79%	4.50%
Operating Efficiency (Operating Hours/Total Hours)		92%	84%	100%
Estimated Annual Cost of Manure Application per Cow		\$109.19	\$79.54	\$160.87
Estimated Annual Cost of Manure Application per Cwt.		\$0.44	\$0.30	\$0.62

Costs by Manure Application Activity

For this study, information was collected for six different activities described with respect to the equipment used: loading and agitation, hauling, spreading, hauling and spreading, incorporation, and custom services. Table 8 reports how much of the total cost for all manure spread on farm, regardless of method, was attributed to each of these activities.

Loading and agitation costs average \$1.37 per 1,000 gallons spread with an 80th percentile range of \$0.47 to \$3.00 per 1,000 gallons. Hauling only costs for farms transferring to a spreader at the

field averaged \$2.03 per 1,000 gallons with a range of \$0.00 to \$6.21. Spreading costs for spreaders in the field averaged \$2.14 per 1,000 gallons applied with a range of \$0.00 to \$4.73 per 1,000 gallons. The \$0.00 cost comes from those farms that haul and spread manure with the same piece of equipment. Hauling and Spreading costs for farms using the same piece of equipment to haul and spread their manure averaged \$2.85 per 1,000 gallons with a range of \$0.00 to \$7.91. Again, a cost of \$0.00 comes from those farms that haul their manure in a tanker to the field and transfer it to a spreader to apply.

There were only a few farms in the study that incorporate manure within 24 hours. The average incorporation cost was \$0.20 per 1,000 gallons spread with a range from \$0.00 for farms not incorporating to \$1.32 on the upper end of the 80th percentile range. The total of these five categories; loading and agitation, hauling, spreading, hauling and spreading and incorporation, make up the total cost of on-farm activities which averaged \$8.58. Total custom service costs averaged \$2.73 per 1,000 gallons with a range from \$0.00 for farms not using custom services to \$9.27 for farms using significant amounts of custom services.

Table 9 reports ownership and operating costs by activity. Table 9 results reflect the specific amount of manure that has handled in each activity.

Table 8

Cost of Manure Hauling				
Total Cost per 1,000 Gallons by Activity Category				
27 Farms, New York State, Spring 2012¹				
				Percent
	Average	Min	Max	of Total
Total Gallons Spread (1,000s)	2,238	382	4,788	
Loading and Agitation	\$1.37	\$0.47	\$3.00	12%
Hauling	\$2.03	\$0.00	\$6.21	18%
Spreading	\$2.14	\$0.00	\$4.73	19%
Hauling and Spreading	\$2.85	\$0.00	\$7.91	25%
Pumping Application	\$0.00	\$0.00	\$0.00	0%
Supplemental Equipment	\$0.00	\$0.00	\$0.00	0%
Incorporation	\$0.20	\$0.00	\$1.32	2%
Total Costs, Farm Activities	\$8.58	\$3.97	\$12.15	76%
Total Cost, Custom Services	\$2.73	\$0.00	\$9.27	24%
Total Cost, All Activities	\$11.31	\$7.56	\$17.05	

¹ This table reports how much of the total costs for all manure spread on the farm, regardless of method, was attributed to each category.

Table 9²

Cost of Manure Application					
Cost per Manure Application Activity per 1,000 Gallons Spread					
27 Farms, New York State , Spring 2012 ¹					
	Loading & Agitation	Hauling	Spreading	Hauling & Spreading	Incorporation
Labor	\$0.09	\$0.83	\$0.68	\$1.07	\$0.06
Fuel & Utilities	\$0.48	\$0.84	\$0.63	\$1.06	\$0.08
Repair	\$0.24	\$0.66	\$0.48	\$0.91	\$0.03
Total Operating Costs	\$0.81	\$2.34	\$1.77	\$3.03	\$0.16
Depreciation	\$0.30	\$0.32	\$0.64	\$0.93	\$0.04
Interest	\$0.25	\$0.30	\$0.58	\$0.76	\$0.05
Insurance	\$0.01	\$0.08	\$0.02	\$0.04	\$0.00
Total Ownership Costs	\$0.56	\$0.69	\$1.24	\$1.74	\$0.08
Total Costs of Farm Activities	\$1.37	\$3.03	\$3.01	\$4.77	\$0.25

¹ This table looks at ownership and operating costs specific to each activity for the manure handled in that activity.

² . Table 8 reports how much of the total cost for all manure spread on farm, regardless of method, was attributed to each category. Table 9 looks at ownership and operating costs specific to each activity for the manure handled in that activity.

Cost of Manure Application by Method

The focus of this study was on farms that utilized tankers to transport and apply liquid manure. Participating farms utilized two different methods for hauling and spreading the manure:

- Loading onto a transport tanker, then off-loading to a spreader in the field (Haul, Transfer, & Spread)
- Loading onto a tanker spreader at the pit, driving to a field, and spreading the load (Haul & Spread)

As part of the study, data was collected from participating farms based on the method utilized. Nine out of 27 participating farms applied manure utilizing both methods during the spring of 2012. For these 9 farms, each method was analyzed individually to determine what the costs were for that method.

Farms using Haul, Transfer and Spread Method

The Haul, Transfer and Spread method is characterized by loading manure on to a tanker at the manure pit and transferring to a manure spreader at the field for application. The costs per 1,000 gallons applied and summary statistics for the 18 farms spreading some manure in this manner are exhibited in Tables 10 and 11, respectively. Average costs were determined as well as the 70th percentile range of the data.

These 18 farms averaged 2,374,230 gallons of manure spread in this manner during the study period with a range from 445,840 gallons to 4,783,790 (Table 10). They covered an average of 3.03 acres per hour, applying 18,463 gallons of manure in that hour, traveling 4.8 miles one way to fields averaging 22.3 acres in size (Table 11). Using this method, these farms can apply on average 2.8% of their estimated total manure for the year in a 10 hour day, with a range from 1.1% to 4.6%. The average investment per 1,000 gallons of manure equaled \$31.25, ranging from \$10.68 to \$51.32.

Operating costs averaged \$6.76 per 1,000 gallons spread, representing 51 percent of the total cost of manure application (Table 10). Labor costs averaged \$2.29 per 1,000 gallons (17% of total costs) with a 70th percentile range from \$0.85 to \$3.38 per 1,000 gallons. Fuel and Utility costs averaged \$2.71 per 1,000 gallons making up 20% of total costs. Rounding out operating costs are repair costs at an average of \$1.77 per 1,000 gallons spread with a range from \$0.45 to \$3.04.

Ownership costs represented 25 percent of total cost per 1,000 gallons. The average depreciation cost was \$1.64 per 1,000 gallons with a range from \$0.75 to \$2.96. Interest cost averaged \$1.48 per 1,000 gallons with a 70th percentile range from \$0.70 to \$3.13 per 1,000 gallons spread.

Insurance costs contributed very little to ownership costs, averaging \$0.15 per 1,000 gallons with a range from \$0.02 to \$0.40.

When added together, ownership costs and operating costs determine the cost of farm activities which accounted for 75% of the total cost to apply manure. The average cost of farm activities was \$10.03 per 1,000 gallons with a 70th percentile range from \$4.36 to \$17.05 per 1,000 gallons. Total cost of custom services averaged \$3.31 per 1,000 gallons with a range from \$0.00 to \$10.19. Custom services made up the remaining 25 % of the total cost. The total cost of applying manure using the haul, transfer and spread method averaged \$13.34 per 1,000 gallons spread with a 70th percentile range from \$8.90 to \$24.20.

Table 10

Cost of Manure Application					
Farms using Haul, Transfer and Spread Method					
Total Cost per 1,000 Gallons Spread					
18 Farms, New York State, Spring 2012					
		70th Percentile Range¹			Percent
		Average	Min	Max	of Total
Total Gallons Spread (1,000s)		2,374	446	4,784	
Operating Costs	Labor	\$2.29	\$0.85	\$3.38	17%
	Fuel & Utilities	\$2.71	\$1.00	\$4.38	20%
	Repair	\$1.77	\$0.45	\$3.04	13%
	Total Operating	\$6.76	\$2.53	\$10.30	51%
Ownership Costs	Depreciation	\$1.64	\$0.75	\$2.96	12%
	Interest	\$1.48	\$0.70	\$3.13	11%
	Insurance	\$0.15	\$0.02	\$0.40	1%
	Total Ownership	\$3.27	\$1.64	\$5.89	25%
Total Cost of Farm Activities		\$10.03	\$4.36	\$17.05	75%
Custom Services Costs	Provided Fuel	\$0.14	\$0.00	\$1.17	1%
	Custom Services	\$3.17	\$0.00	\$10.19	24%
	Other Fees	\$0.00	\$0.00	\$0.00	0%
Total Cost of Custom Services		\$3.31	\$0.00	\$10.19	25%
Total Cost, All Activities		\$13.34	\$8.90	\$24.20	

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Table 11

Cost of Manure Application				
Farms using Haul, Transfer and Spread Method				
Summary Statistics				
18 Farms, New York State, Spring 2012				
			70th Percentile Range	
	Average	Min	Max	
Acres Covered per Operating Hour of Manure Application				
	3.03	1.4	4.81	
Average Field Size, Acres	22.33	9.2	51.6	
Average Number of Cows	909	251	1,351	
Average Distance to Fields, One Way, Miles ¹	4.80	2.85	10.20	
Average Travel Time, Round Trip, Minutes ¹	35.90	23.38	51.85	
Average Travel Time per Mile, Minutes ¹	2.75	1.80	3.60	
Gallons of Manure Spread per Application Hour				
	18,463	9,611	28,786	
Manure Application Capacity in a 10 Hour Day as % of Total Manure for Year	2.80%	1.10%	4.60%	
Percent of Estimated Total Manure Analyzed	24.8%	5.7%	45.9%	
Gallons of Fuel Used per 1,000 Gallons of Manure Spread	0.82	0.3	1.64	
Operating Efficiency (Operating Hours/Total Hours)				
	95.0%	89.0%	99.6%	
Cost per Worker Equivalent	\$43,772	\$34,382	\$55,200	
Labor Hours per 1,000 gallons of Manure	0.14	0.069	0.193	
Investment in Manure Equipment per 1,000 Gallons	\$31.25	\$10.68	\$51.32	
Investment in Manure Equipment per cow	\$247.13	\$139.35	\$352.56	
Average Useful Life of Equipment, Years	28.6	12.66	40.29	
Equipment Salvage Value, Percent of Original Investment				
	30.80%	13.70%	48.10%	
Total all Cost per Load		\$78.31	\$41.80	\$114.13
Total all Cost per Acre		\$85.38	\$54.54	\$120.22
¹ 12 Farms Reporting Data for Distance and Travel Time				

Table 12 compares the hauling costs for farms that haul, transfer and spread manure using custom manure hauling to the field. Seven farms used custom operators to haul manure from the pit to the field. On average these custom operators hauled 226 loads of manure adding up to 1,659,000 gallons or 7,071 tons over 152 hours. Custom operators hauled 10,303 gallons of manure per hour. Custom hauling cost on average \$86.38 per hour, \$9.05 per 1,000 gallons and \$63.23 per load for these seven farms.

Table 12

Cost of Manure Application					
Custom Services Summary, Hauling Only					
Farms using Haul, Transfer and Spread Method					
Total Cost per 1,000 Gallons					
7 Farms, New York State, Spring 2012					
		Hours	1,000 Gallons	Tons	Loads
Total Amounts for Study Period		152	1,659	7,071	226
Custom Services Costs					
	Provided Fuel	\$4.18	\$0.40	\$0.08	\$3.13
	Custom Services	\$82.20	\$8.65	\$2.03	\$60.09
	Other Fees	\$0.00	\$0.00	\$0.00	\$0.00
Total Cost of Custom Services		\$86.38	\$9.05	\$2.11	\$63.23
Gallons of Manure Hauled Per Hour		10,303			

Cost of Manure Application for Farms using the Haul and Spread Method

The second method analyzed was the haul and spread method. This method is characterized by loading manure at the manure pit and applying manure to the field with that piece of equipment without transferring the manure. The costs per 1,000 gallons applied for the 18 farms spreading some manure in this manner are exhibited in Table 13. Average costs were determined as well as the 70th percentile range of the data. These 18 farms averaged 708,160 gallons of manure spread during the study period with a range from 190,460 gallons to 1,206,980 gallons. These farms spread on average 11,530 gallons per hour, covering 2.16 acres per hour. The average field was 2.35 miles away from the farm, and one load of manure took 31.6 minutes. In a 10 hour day, these farms can apply 1.6% of their estimated total manure for the year. Investment in manure equipment averaged \$23.88 per 1,000 gallons. All of these summary statistics are shown in Table 14.

Operating costs averaged \$5.66 per 1,000 gallons spread, 61 percent of the total cost of manure application (Table 13). Labor costs averaged \$1.77 with a 70th percentile range from \$0.96 to \$2.84 per 1,000 gallons. Fuel and Utility costs averaged \$2.18 per 1,000 gallons making up 23% of total costs. Repair costs average of \$1.71 per 1,000 gallons spread with a range from \$0.54 to \$2.61.

Ownership costs represented 34 percent of total cost per 1,000 gallons (Table 13). The average depreciation cost was \$1.70 per 1,000 gallons with a range from \$0.80 to \$2.52. Interest cost averaged \$1.44 per 1,000 gallons with a 70th percentile range from \$0.62 to \$2.44 per 1,000 gallons spread. Insurance costs contributed very little to ownership costs, averaging \$0.08 per 1,000 gallons with a range from \$0.02 to \$0.12.

Cost of farm activities, the total of operating and ownership costs, make up 95% of the total cost to apply manure on farms using the haul and spread method (Table 13). The average cost of farm operations was \$8.87 per 1,000 gallons spread with a 70th percentile range from \$4.55 to \$12.62 per 1,000 gallons. Total cost of custom services averaged \$0.46 per 1,000 gallons. Custom services made up 5 % of the total cost. The total cost of applying manure using the haul and spread method averaged \$9.34 per 1,000 gallons spread with a 70th percentile range from \$4.55 to \$15.40.

Table 13

Cost of Manure Application					
Farms using Haul and Spread Method					
Total Cost per 1,000 Gallons Spread					
18 Farms, New York State, Spring 2012					
			70th Percentile Range ¹		Percent
		Average	Min	Max	of Total
Total Gallons Spread (1,000s)		708	190	1,207	
Operating Costs	Labor	\$1.77	\$0.96	\$2.84	19%
	Fuel & Utilities	\$2.18	\$0.85	\$3.35	23%
	Repair	\$1.71	\$0.54	\$2.61	18%
	Total Operating	\$5.66	\$2.87	\$7.64	61%
Ownership Costs	Depreciation	\$1.70	\$0.80	\$2.52	18%
	Interest	\$1.44	\$0.62	\$2.44	15%
	Insurance	\$0.08	\$0.02	\$0.12	1%
	Total Ownership	\$3.22	\$1.63	\$4.96	34%
Total Cost of Farm Activities		\$8.87	\$4.55	\$12.62	95%
Custom Services Costs	Provided Fuel	\$0.00	n/a	n/a	0%
	Custom Services	\$0.46	n/a	n/a	5%
	Other Fees	\$0.00	n/a	n/a	0%
Total Cost of Custom Services		\$0.46	n/a	n/a	5%
Total Cost, All Activities		\$9.34	\$4.55	\$15.40	

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Table 14

Cost of Manure Application				
Farms using Haul and Spread Method				
Summary Statistics				
18 Farms, New York State, Spring 2012				
			70th Percentile Range	
	Average	Min	Max	
Acres Covered per Operating Hour of Manure	2.16	1.05	2.95	
Average Field Size, Acres	22.38	7.34	40.29	
Average Number of Cows	753	260	1,036	
Average Distance to Fields, One Way, Miles ¹	2.35	0.74	5.3	
Average Travel Time, Round Trip, Minutes	31.6	22.14	43.92	
Average Travel Time per Mile, Minutes	5.03	2.45	8.61	
Gallons Manure Spread per Application Hour	11,530	6,175	15,398	
Manure Application Capacity in a 10 Hour Day	1.60%	0.01%	3.60%	
Percent of Estimated Total Manure Analyzed	10%	2%	20%	
Operating Efficiency(Operating Hr/Total Hr)	93.0%	89.0%	99.3%	
Cost per Worker Equivalent	41,904	32,827	55,200	
Labor Hours per 1,000 gallons of Manure Spread	0.12	0.07	0.21	
Investment in Manure Equipment per 1,000 Gallons	\$23.88	\$6.58	\$40.78	
Average Useful Life of Equipment, Years	17.1	9.72	26.1	
Equipment Salvage Value, Percent of Original	29.7%	16.0%	43.0%	
Total of All Costs per Load	\$53.11	\$27.53	\$75.04	
Total of All Costs per Acre	\$52.07	\$25.22	\$89.38	
¹ 17 Farms Reporting Data for Distance and Travel Time				

Analysis of Types of Equipment Utilized

Participating farms provided information for every piece of equipment used for applying liquid manure including the tasks performed. With this detail, costs associated with certain types of equipment doing specific tasks were analyzed.

Hauling of Liquid Manure, Transporting Only

Table 15 summarizes the costs and selected summary statistics associated with trucks used to transport manure from the pit to spreaders in the field. Farms either used 10 wheel straight trucks with tanks or semi-trucks pulling tanker trailers. The straight trucks averaged \$5.02 per 1,000 gallons hauled and semi-trucks averaged \$6.35 per 1,000 gallons. While the semi-trucks costs average \$1.33 per 1,000 gallons higher than the straight trucks, the breakdown of expenses on a percentage basis was very similar, with operating costs representing 80% of the total costs, and ownership costs the remaining 20%.

One of the major differences in costs between the two types of trucks was turns per hour (Table 16). Straight trucks averaged 2.63 turns an hour, traveling 3.11 miles to the field, while the semi-trucks averaged 1.43 turns per hour, traveling on average 6.02 miles to the field. While the semi-trucks traveled further and averaged over 1 less turn per hour, they hauled almost the same amount of manure in one hour because of a larger tanker size (11,260 gallons per hour for 10-wheelers vs 10,360 gallons per hour for semi-truck and tanker).

An attempt was made to look at how costs changed as the distance traveled increased for the trucks. Farms provided information on distance to fields along with number of loads, labor hours, and fuel used for that location. For the 10 wheel trucks, cost per load increased \$0.26 per 1,000 gallons for every additional mile traveled. For the semi-trucks, the cost increased \$0.55 per additional mile traveled. For both the 10 wheel trucks and the semi-trucks, the average increase in cost per mile traveled for the lowest 15% of vehicles was very similar, while the highest 15% of vehicles was quite different. The authors feel that this is a result of the distance traveled by the equipment during the study period. For these farms, the 10 wheel trucks travel relatively short distances, showing only a range of 2.34 to 3.88 miles. The semi-trucks traveled over a much greater range, from 2.64 miles to 10.13 miles. This in part led to a difference in the range of costs per mile traveled.

Table 15

Cost of Manure Application									
Comparison of Different Types of Hauling Equipment									
Farms using Haul, Transfer and Spread Method									
Total Cost per 1,000 Gallons Spread									
New York State, Spring 2012									
		10-Wheeler # of Units Analyzed: 15				Semi Tractor and Tanker Trailer # of Units Analyzed: 17			
		70th Percentile Range ¹				70th Percentile Range ¹			
		Average	Min	Max	Percent of Total	Average	Min	Max	Percent of Total
Total Gallons Spread (1,000s)		1072.29	333.38	1691.58		790.07	230.96	1,440.55	
Operating Costs	Labor	\$1.45	\$1.07	\$1.83	28.8%	\$1.88	\$1.29	\$2.51	29.6%
	Fuel	\$1.29	\$1.02	\$1.48	25.8%	\$1.86	\$1.42	\$2.49	29.4%
	Repair	\$1.27	\$0.56	\$2.01	25.2%	\$1.34	\$0.77	\$2.00	21.1%
	Total Operating	\$4.01	\$2.89	\$5.23	79.8%	\$5.08	\$4.27	\$5.84	80.0%
Ownership Costs	Depreciation	\$0.45	\$0.19	\$0.71	8.9%	\$0.51	\$0.18	\$0.79	8.0%
	Interest	\$0.45	\$0.26	\$0.60	8.9%	\$0.50	\$0.24	\$0.74	7.9%
	Insurance	\$0.11	\$0.04	\$0.17	2.3%	\$0.25	\$0.04	\$0.60	4.0%
	Total Ownership	\$1.01	\$0.55	\$1.48	20.2%	\$1.27	\$0.52	\$1.84	20.0%
Total All Costs		\$5.02	\$3.67	\$6.78		\$6.35	\$5.49	\$7.38	

¹ Each cost category is reported independently. Min and Max values reported in this table are not additive.

Table 16

Cost of Manure Application							
Comparison of Different Types of Hauling Equipment							
Farms using Haul, Transfer and Spread Method							
Summary Statistics							
New York State, Spring 2012							
		10-Wheeler			Semi Tractor and Tanker Trailer		
		# of Units Analyzed: 15			# of Units Analyzed: 17		
		70th Percentile Range			70th Percentile Range		
		Average	Min	Max	Average	Min	Max
Acres Covered per Operating Hour		2.65	1.40	4.22	1.47	0.99	2.22
Average Field Size, Acres		23.63	4.78	44.01	37.92	12.89	66.01
Gallons of Fuel Used per Operating Hour		4.09	3.18	4.78	5.11	4.04	6.30
Operating Efficiency(Operating Hr/Total Hr)		90%	88%	94%	90%	84%	96%
Turns per Operating Hour, Loads		2.63	2.23	3.35	1.43	1.04	2.01
Manure Hauled per Operating Hour, Gallons		11.26	10.45	12.89	10.36	7.74	12.84
Time per Load, Minutes		23.51	18.26	26.84	44.53	29.81	57.33
Average Distance to Fields, One Way		3.11	2.34	3.88	6.02	2.64	10.13
Travel Time per mile		2.75	1.70	3.88	2.64	1.80	4.11
Investment in Manure Equipment per 1,000 Gallons		\$10.48	\$5.90	\$15.69	\$11.77	\$5.06	\$18.29
Average Useful Life of Equipment		17.33	10.00	20.00	17.66	15.00	22.78
Salvage Value, Percent of Original Investment		26%	10%	58%	28%	12%	38%
Estimated Increase in Cost per Load per Mile Traveled		\$1.13	\$0.42	\$1.82	\$4.04	\$1.05	\$8.59
Estimated Increase in Cost per Load per Minute of Travel Time		\$0.81	\$0.09	\$2.16	\$1.29	\$0.37	\$2.32
Estimated Increase in Cost per Mile Traveled per 1,000 Gallons		\$0.26	\$0.12	\$0.35	\$0.55	\$0.16	\$1.04
Total All Costs per Load		\$21.86	\$14.27	\$29.17	\$44.24	\$32.19	\$54.98
Total Costs per Hour		\$51.15	\$36.88	\$67.21	\$56.08	\$38.94	\$73.24
Load Size, Gallons		4,367	3,520	5,205	7,320	6,534	8,264

Spreading of Liquid Manure, Loading at Field

The second equipment activity analyzed, also associated with the haul, transfer, and spread method, was spreading equipment in the field. On the participating farms, these were exclusively tractors pulling spreaders, with and without injection. For spreaders not injecting but rather surface applying manure, the total cost per 1,000 gallons was \$4.48, ranging from \$2.31 to \$8.28 per 1,000 (Table 17). Operating costs were 59% of the total costs, with ownership costs accounting for the remaining 41%. Farms that had injectors on the spreaders averaged \$5.11 per 1,000 gallons, ranging from \$3.50 to \$7.78 per 1,000 gallons. Operating costs represented 63% of the total costs, and ownership costs were 37%.

Farms that used spreaders with injectors had a higher investment per 1,000 gallons for slightly smaller spreaders in gallon capacity than spreaders without injectors (Table 18). Spreaders with injectors applied higher levels of manure per acre. All of these factors led to the higher costs per 1,000 gallons applied for spreaders with injectors.

Table 17

Cost of Manure Application									
Comparison of Different Types of Spreading Equipment									
Farms using Haul, Transfer and Spread Method									
Total Cost per 1,000 Gallons Spread									
New York State, Spring 2012									
		Tractor and Spreader, No Injection				Tractor and Spreader, With Injection			
		# of Spreaders Analyzed: 17				# of Spreaders Analyzed: 11			
		70th Percentile Range ¹				70th Percentile Range ¹			
		Average	Min	Max	Percent of Total	Average	Min	Max	Percent of Total
Total Gallons Spread (1,000s)		1274.24	175	3,029		1776.05	116	4,139	
Operating Costs	Labor	\$1.03	\$0.69	\$1.53	23.0%	\$1.27	\$0.51	\$2.75	24.8%
	Fuel	\$0.85	\$0.45	\$1.52	19.0%	\$1.00	\$0.46	\$1.89	19.6%
	Repair	\$0.75	\$0.26	\$1.95	16.7%	\$0.95	\$0.47	\$1.88	18.6%
	Total Operating	\$2.63	\$1.55	\$4.44	58.7%	\$3.22	\$1.36	\$6.50	63.0%
Ownership Costs	Depreciation	\$1.06	\$0.35	\$2.10	23.7%	\$0.73	\$0.32	\$1.24	14.3%
	Interest	\$0.76	\$0.21	\$1.49	17.0%	\$1.12	\$0.49	\$2.20	21.9%
	Insurance	\$0.02	\$0.01	\$0.03	0.6%	\$0.04	\$0.01	\$0.08	0.7%
	Total Ownership	\$1.85	\$0.64	\$3.27	41.3%	\$1.89	\$0.99	\$3.55	36.9%
Total All Costs		\$4.48	\$2.31	\$8.28		\$5.11	\$3.50	\$7.78	

Table 18

Cost of Manure Application							
Comparison of Different Types of Spreading Equipment							
Farms using Haul, Transfer and Spread Method							
Summary Statistics							
New York State, Spring 2012							
		Tractor and Spreader, No Injection			Tractor and Spreader, With Injection		
		# of Spreaders Analyzed: 17			# of Spreaders Analyzed: 11		
		70th Percentile Range			70th Percentile Range		
		Average	Min	Max	Average	Min	Max
Acres Covered per Operating Hour		3.83	1.91	6.36	2.76	1.65	4.45
Average Field Size, Acres		35.05	14.41	62.21	18.00	12.79	22.79
Gallons of Manure Spread per Acre		6,038	n/a	n/a	8,108	n/a	n/a
Gallons of Fuel used per Operating Hour		4.39	2.16	6.16	4.21	2.42	6.42
Operating Efficiency(Operating Hr/Total Hr)		93%	86%	98%	95%	87%	99%
Turns per Operating Hour, Loads		3.43	2.13	4.85	3.40	1.77	4.87
Manure Hauled per Operating Hour, Gallons		18.84	12.19	26.99	16.93	7.57	24.70
Time per Load, Minutes		20.10	12.37	28.95	20.82	12.68	34.08
% Time Spent Filling		30.22	16.05	39.96	20.27	6.50	31.70
Investment in Manure Equipment per 1,000 Gallons		\$17.25	\$5.63	\$29.26	\$22.94	\$10.33	\$41.33
Average Useful Life of Equipment		17.18	9.64	24.16	18.74	8.46	30.00
Salvage Value, Percent of Original Investment		26%	12%	45%	41%	13%	67%
Total All Costs per Load		\$23.54	\$14.42	\$43.05	\$25.62	\$15.00	\$37.21
Total Costs per Hour		\$68.78	\$38.79	\$115.40	\$72.08	\$53.87	\$92.73
Load Size, Gallons		5,628	4,000	7,063	5,079	3,750	7,084

Hauling and Spreading Liquid Manure with Same Piece of Equipment

Tables 19 and 20 summarize the costs and summary statistics for equipment used to haul and spread manure. Farms either used 10 wheel vehicles with tanks, semi-trucks pulling tanker trailers, or farm tractors pulling tanker trailers. A 70th percentile range was not reported for 10-wheel straight trucks because there were only four of these units analyzed. The 10-wheeler straight trucks averaged \$8.02 per 1,000 gallons hauled, semi-trucks averaged \$8.54 per 1,000 gallons, and tractors with spreaders averaged \$6.62 per 1,000 gallons. Operating costs made up 69% of the total costs for 10-wheelers and the remaining percentage was for ownership costs. For semi-tractors towing a tanker spreader, operating costs made of 51.6% of total costs with ownership costs contributing the remaining 48.4%. For tractors with spreaders 58.6% of the total costs were from operating costs and 41.4% was ownership costs.

One of the differences in costs, similar to trucks hauling and transferring, was turns per hour. 10-wheelers and semi-tractors with a spreader averaged 1.88 and 1.77 turns per hour respectively with a distance to the field about the same at 3.43 and 3.58 miles one way, while

farm tractors with a spreader averaged 2.23 turns per hour and traveled a much shorter distance to the field with an average distance of 1.55 miles one way.

An attempt was made to look at how costs changed as the distance traveled increased. Farms provided information on distance to fields along with number of loads, labor hours, and fuel used for that location. For the 10 wheel trucks, costs increased \$4.32 per load for every additional mile traveled. For the semi-trucks with tankers, the cost per load increased \$3.17 per additional mile traveled, and for tractors with spreaders the cost per load increased \$4.91 per mile traveled. Also contributing to the increased cost per mile traveled is the travel time per mile. 10- wheelers and semi-tractors with trailers averaged about the same at 2.9 minutes per mile whereas tractors with spreaders averaged 5.85 minutes per mile. While tractor pulled spreaders had higher turns per hour and the lowest cost per 1,000 gallons, the cost per load of a farm owned tractor and spreader increased the most per mile traveled.

Table 19

Cost of Manure Application									
Comparison of Different Types of Hauling and Spreading Equipment									
Farms using Haul and Spread Method									
Total Cost per 1,000 Gallons Spread									
New York State, Spring 2012									
		10-Wheeler # of Units Analyzed: 4		Semi Tractor and Tanker Trailer # of Units Analyzed: 6		Farm Tractor & Spreader # of Units Analyzed: 16			
		Average	Percent of Total	Average	Percent of Total	70th Percentile Range ¹		Max	Percent of Total
Total Gallons Spread (1,000s)		218		314		594	190	1161	
Operating Costs	Labor	\$1.72	21.4%	\$1.20	14.1%	\$1.41	\$0.84	\$2.03	21.3%
	Fuel	\$1.77	22.1%	\$1.11	13.0%	\$1.43	\$0.64	\$2.20	21.6%
	Repair	\$2.03	25.3%	\$2.10	24.6%	\$1.04	\$0.27	\$1.84	15.7%
	Total Operating	\$5.53	69.0%	\$4.41	51.6%	\$3.88	\$2.35	\$6.05	58.6%
Ownership Costs	Depreciation	\$1.46	18.2%	\$2.28	26.7%	\$1.48	\$0.66	\$1.92	22.4%
	Interest	\$0.99	12.3%	\$1.68	19.7%	\$1.21	\$0.57	\$1.93	18.3%
	Insurance	\$0.05	0.6%	\$0.18	2.1%	\$0.06	\$0.03	\$0.09	0.9%
	Total Ownership	\$2.49	31.0%	\$4.13	48.4%	\$2.74	\$1.42	\$3.78	41.4%
Total All Costs		\$8.02		\$8.54		\$6.62	\$3.66	\$9.83	

¹ Each cost category is reported independently. Min and Max costs reported in this table are not additive.

Table 20

Cost of Manure Application						
Comparison of Different Types of Hauling and Spreading Equipment						
Farms using Haul and Spread Method						
Summary Statistics						
New York State, Spring 2012						
		10-Wheeler # of Units Analyzed: 4	Semi Tractor and Tanker Trailer # of Units Analyzed: 6	Farm Tractor & Spreader # of Units Analyzed: 16		
					70th Percentile Range	
		Average	Average	Average	Min	Max
Acres Covered per Operating Hour		1.93	2.20	2.39	1.77	3.17
Average Field Size, Acres		32.36	24.72	23.18	7.86	40.84
Gallons of Fuel Used per Operating Hour		3.83	3.98	5.01	2.92	7.73
Operating Efficiency(Operating Hr/Total Hr)		84%	91%	94%	89%	99%
Turns per Operating Hour, Loads		1.88	1.77	2.23	1.66	2.72
Manure Hauled per Operating Hour,		8,180	13,310	13,180	8,270	17,630
Time per Load, Minutes		33.70	35.67	28.99	22.11	74.11
Average Distance to Fields, One Way		3.43	3.58	1.55	0.67	36.34
Travel Time per mile, minutes		2.90	2.87	5.85	3.42	8.81
Investment in Manure Equipment per 1,000 gallons		\$24.13	\$39.96	\$26.09	\$12.55	\$43.21
Average Useful Life of Equipment		13.30	14.03	15.80	6.40	25.69
Salvage Value, Percent of Original Investment		16%	16%	38%	23%	53%
Estimated Increase in Cost per Load per Mile Traveled		\$4.32	\$3.17	\$4.91	\$2.14	\$9.26
Estimated Increase in Cost per Load per Minute of Travel Time		\$1.06	\$1.67	\$1.17	\$0.55	\$2.23
Total All Costs per Load		\$25.99	\$66.90	\$38.67	\$20.84	\$65.72
Total Costs per Hour		\$38.45	\$106.07	\$69.42	\$37.90	\$116.36
Load Size, Gallons		4,288	7,272	6,055	4,487	7,030

Factors Affecting Manure Application Costs

Given the wide range in the costs to apply 1,000 gallons of manure across farms, the data was analyzed to determine what factors that best explained the variability in the costs associated with manure application. Two factors were identified across these farms.

Manure Application Capacity in a 10 Hour Day as a % of Total Manure for Year

Manure application capacity in a 10 hour day, as a percent of total manure for year, represents how much of the estimated total manure for the year can be applied in this time frame. As the percent increased, the investment level in manure spreading equipment as measured by investment per cow increased (Chart 1). Increased capacity was not associated with changes in the operating cost per 1,000 gallons (Chart 2). However, the increased investment per cow did lead to an increase in ownership cost per 1,000 gallons (Chart 3). Generally, the farms with higher percent capacity had more pieces of equipment to apply manure, leading to less total manure going through each piece of equipment over a years' time.

Chart 1

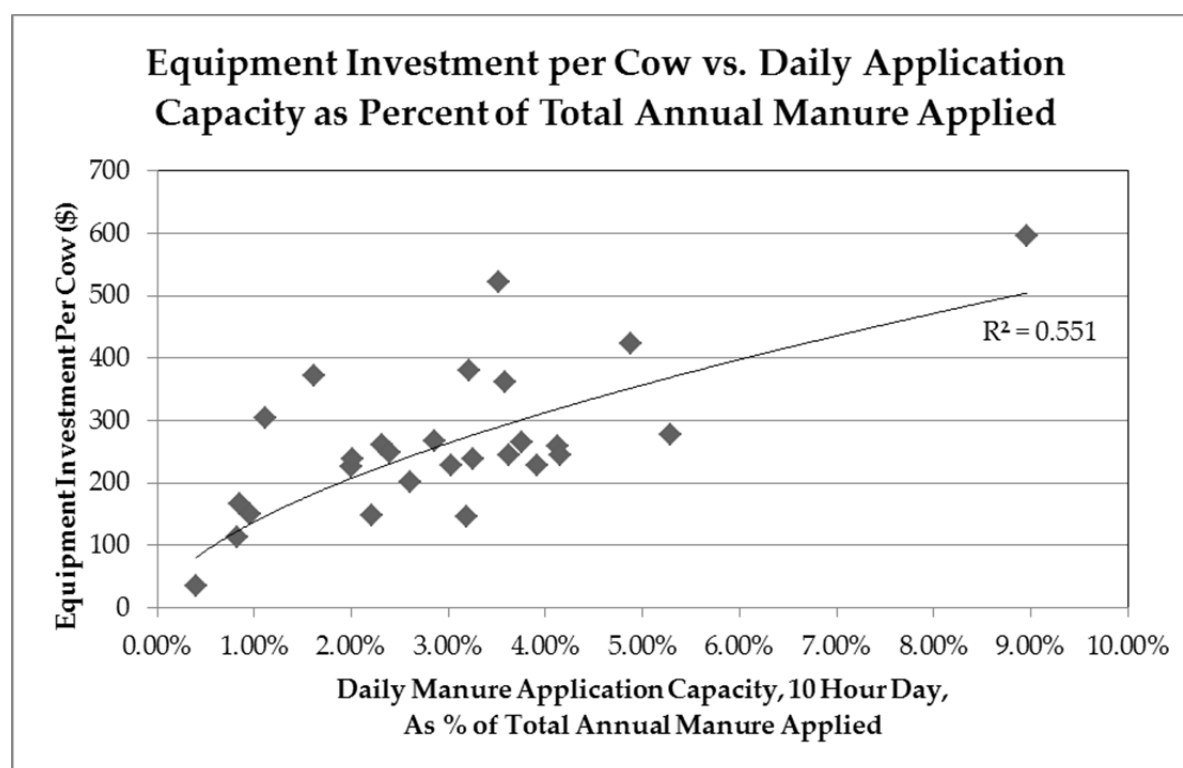


Chart 2

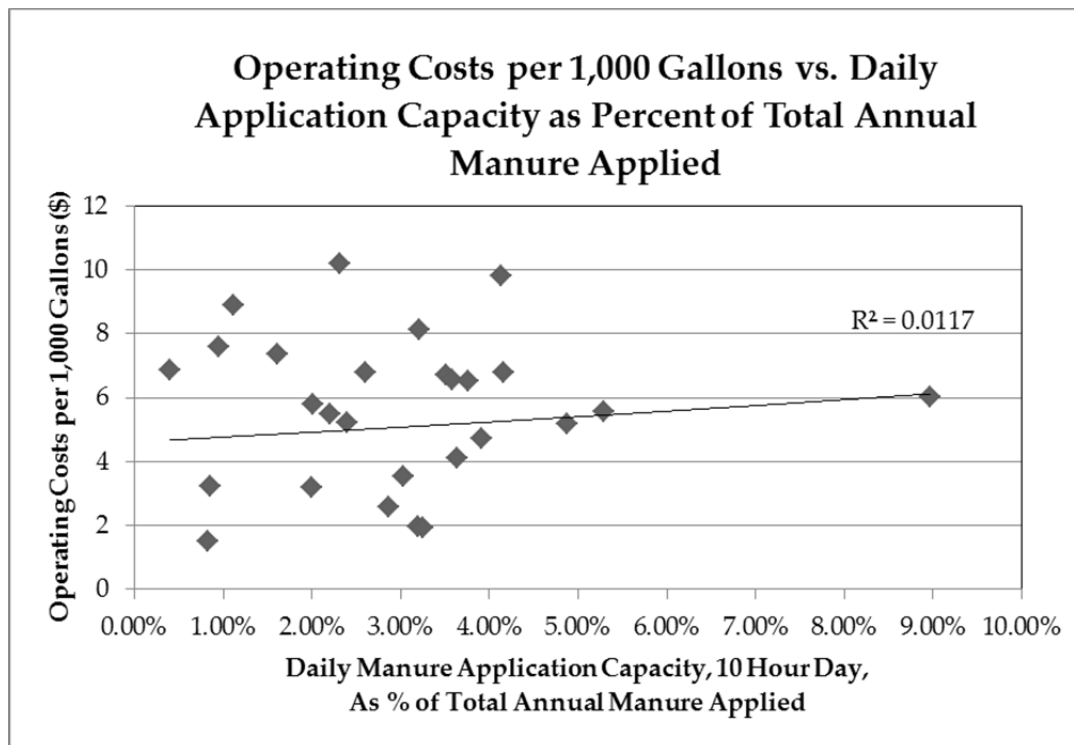
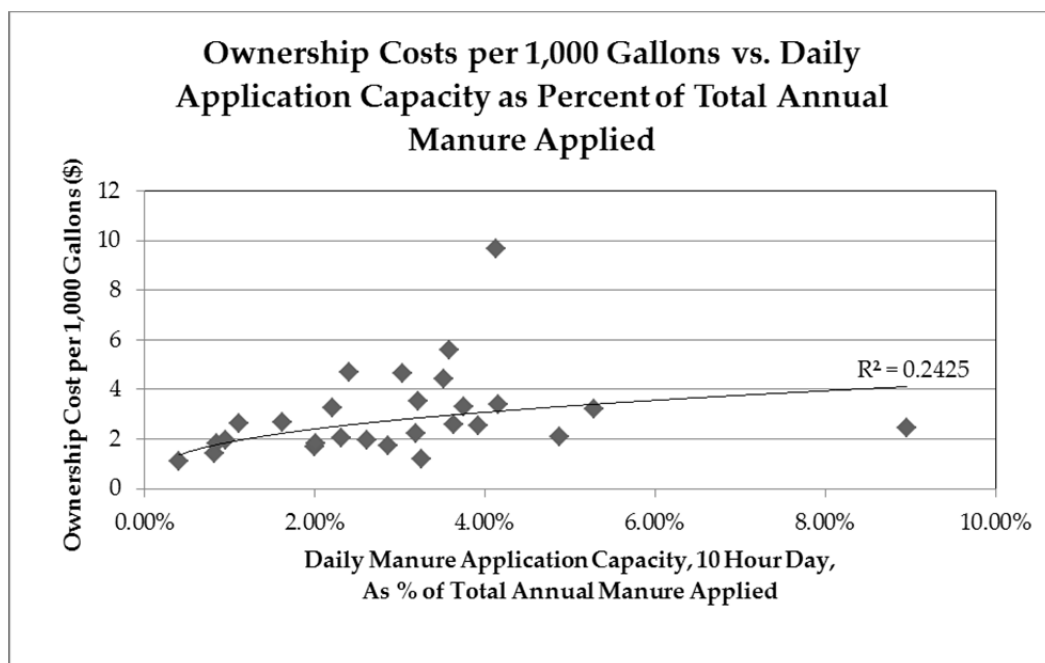


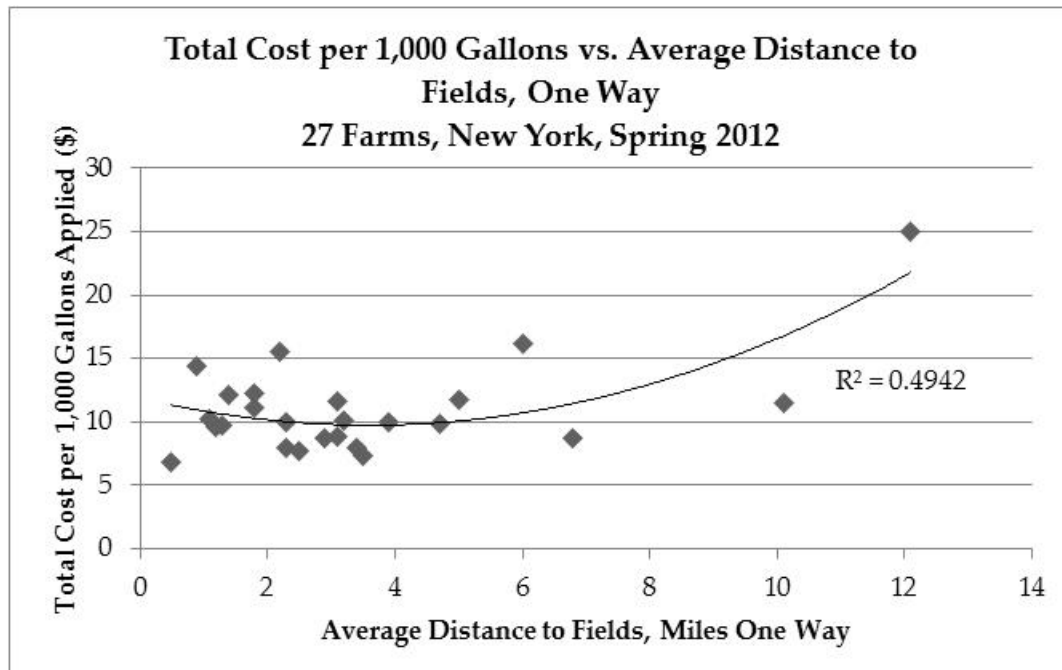
Chart 3



Distance to Fields

The second factor that impacted costs to apply manure was distance to fields. Chart 4 shows the relationship between cost per 1,000 gallons and the average distance to the field, one way, for all equipment that was hauling manure to the field regardless of it being transferred to a spreader or not. As distance increased, so did the total cost per 1,000 gallons of manure applied.

Chart 4



Summary

Manure application is a key task performed by dairy farms every year. For the 27 farms in the study, the cost to load, transport, and spread 1,000 gallons averaged \$11.31, ranging from \$7.56 to \$17.05. About 2.6 acres were covered per operating hour, with the average field size being 20.26 acres. The average distance to the fields was 3.1 miles with a range of 1.0 mile to 8.1 miles.

Operating costs represented one half of the total costs, averaging \$5.63 per 1,000 gallons applied. Fuel was the largest operating expense at 19% of the total. Ownership costs represented another 26% of the total costs, with depreciation and opportunity cost of interest each representing 12-13% of the total costs. Custom services accounted for the remainder of the total costs, representing 24% of the total.

During a 10 hour day, the average amount of manure applied was 234,473 gallons. This amount represented 3% of the total estimated annual liquid manure for the participating farms. The range in the % of the total liquid manure that could be applied in a 10 hour day was from 0.8% to 5%. As the % capacity increased, so did the ownership costs associated with manure equipment and the costs associated with applying 1,000 gallons.

Costs were broken down into different equipment activities. Costs for those activities were determined based on all of the manure the farm applied along with how much manure was handled by that equipment activity. The largest contributor to total costs on these farms was hauling and spreading with the same piece of equipment at 25%. Next were hauling to the field and spreading in the field separately at 18% and 19% respectively. Loading and agitating manure at the pit made up 12% of total costs. All farm activities were about 76% of total costs whereas custom services made up 24% of the total costs.

Farms applied manure in one of two ways. The first is the haul, transfer and spread method characterized by farms that load manure on to a tanker at the manure pit and transfer to a manure spreader at the field to apply. The second is the haul and spread method when farms load manure at the pit and then apply the manure to the field without transferring it. The total cost to apply manure using the haul, transfer and spread method was \$13.34 per 1,000 gallons, ranging from \$13.34 to \$24.20. On average farms using this method covered 3.03 acres per operating hour with an average field size of 22.33 acres. Fields were 4.8 miles from the pit with a range from 2.85 miles to 10.2 miles. The application capacity of these farms in a 10 hour day was 2.8% of total estimated annual manure production with a range from 1.10% to 4.6%.

The manure application costs on farms using the haul and spread method averaged \$9.34 per 1,000 gallons with a range from \$4.55 to \$15.40. These farms covered an average of 2.16 acres per operating hour and field size averaged 22.38 acres. Fields were on average 2.35 miles from the manure pit with a range from 0.74 miles to 5.3 miles. The application capacity of these farms was 1.6% of annual estimated manure production with a range of 0.01% to 3.6%.

Key factors in determining differences in cost of manure application among the farms in the study were manure application capacity and distance to the field. As application capacity increased as a percent of total estimated manure applied in a year, the investment in machinery increased as well. As the distance to the field increased, regardless of the method of manure application, the cost per 1,000 gallons increased.

Appendix: Definition of Measures Calculated

1,000 Gallons: The sum of the manure applied by spreading, hauling & spreading equipment during the study period, on a per 1,000 gallon basis. If only solid manure was spread during the study period, then this will be zero.

Acres Covered per Operating Hour of Manure Application: Acres covered per application hour. Hours are those operating hours associated with direct application of the manure in the field.

Application Hours: The total hours spent by equipment applying manure to the field. It is the total of spreading, and hauling & spreading hours. Total hours is all hours, including the time spent each day fueling, checking the oil, and other services performed each day.

Average Distance to the Field, One Way, Miles: The weighted average distance to the field from the manure pit as estimated by the farm.

Average Travel Time, Round Trip, Minutes: The weighted average time it takes to make one trip to the field and back to the manure pit.

Average Useful Life: The average number of years that all the equipment that is utilized to apply manure is expected to be owned by the farms.

Cost per Worker Equivalent: The total cost per worker for a year's time, based on 2,760 hours of labor, the standard worker equivalent as defined by the Cornell Dairy Farm Business Summary.

Estimated Cost of Manure Application per Cow: Total cost for period and estimated total for the year on a per cow basis. Total cost for period or estimated total cost for year divided by average number of milking and dry cows for the year.

Estimated Cost of Manure Application per Cwt. Of Milk Produced for the Year: Total cost for the period and estimated total for the year on a per hundredweight (cwt.) of milk produced basis. Total cost for period or estimated total cost for the year divided by estimated total cwt. of milk produced for the year.

Estimated Total Gallons of Manure Spread per Mature Cow per Year: The estimated total manure is all liquid manure, not just the liquid manure that may be applied utilizing the method that was analyzed during the study period. Estimated total manure spread during the year provided by the farm, divided by total the average number of mature cows, milking and dry, for the year.

Gallons of Fuel Used per 1,000 gallons of Manure Applied: Total gallons of fuel used by all equipment, including fuel provided to custom services, divided by total gallons of manure applied by farm activities, multiplied by 1,000. Gallons applied by custom application are not included in this measure

Gallons of Fuel Used per Acre: Total gallons of fuel used by all equipment, including fuel provided to custom services, divided by the acres that manure was applied to by farm activities. Acres covered by custom application are not included in this number.

Investment in Manure Equipment: The total initial investment in manure equipment. For equipment that is used for additional activities outside of manure spreading, the initial investment for that piece of equipment is determined by the total initial investment times the % of the equipment's time that is spent applying manure. This isn't a measure of what the current value of the machinery is or what the cost basis value is, but reflects what the initial investment was at the time the equipment was purchased. The total investment divided by average number of milking and dry cows, hundredweight of milk produced, or the total manure gallons handled by the equipment over a year's time.

Labor Hours per 1,000 gallons of Manure Spread: Total hours of labor utilized to apply 1,000 gallons of manure. Total labor hours utilized in all farm activities divided by total gallons of manure applied by spreading, hauling and spreading, or hose application.

Labor Hours per Acre: Number of labor hours utilized to cover 1 acre with manure. Total hours of labor utilized in all farm activities divided by the number of acres covered.

Loads: The total loads of manure applied by spreading and haul & spreading equipment.

Manure Application Capacity as a Percent of Estimated Total Manure: The percent of the estimated total manure for the year that can be applied in one 10 hour day.

Manure Application Capacity in a 10 Hour Day: Calculated measure estimating the amount of manure that could be applied during a 10 hour day. Calculation based on the amount of manure being applied per operating hour by spreading, hauling & spreading, and hose application equipment and the average operating efficiency of all the equipment. If all the manure was applied in the manner analyzed during the study period to fields of similar size and distance from the farm, this number would represent the amount of liquid manure that could be applied during a 10 hour day, including time associated with getting ready to operate that day.

Manure Spread per Acre: Total gallons or tons of manure applied during study period divided by acres.

Manure Spread per Application Hour: Total gallons or tons of manure applied during study period divided by application hours.

Manure Spread per Labor Hour: Total gallons or tons of manure applied during study period divided by total labor hours from all activities associated with loading, transporting, and applying manure.

Manure Spread per Mature Cow: Total gallons or tons of manure applied during study period divided by the average number of mature cows, milking and dry, for the year.

Operating Application Hours: The hours of operating time spent by equipment that applied manure to the field. It is the sum of the operating hours for spreading, hauling & spreading equipment. Operating hours do not include the time spent fueling, checking the oil, and other services performed each day. Operating hours are when labor was employed with that piece of equipment, regardless of whether it was actually operating or waiting to load, spread, etc.

Operating Efficiency: Percent of total hours equipment was operating. Operating hours divided by total hours.

Salvage Value as a Percent of Original Investment: Represents the value of the equipment at the end of the useful life on the farm, at which point the equipment is sold or traded in. It is calculated by dividing the salvage value of the equipment by the initial investment in equipment.

Tons: The total tons of manure applied. It is calculated by multiplying the gallons of manure by the weight of one gallon, taken from the manure analysis, and dividing by 2,000 lbs. If only solid manure was applied during the study period, then the sum of the total tons applied is utilized.

Total Acres: The total acres that were covered during the study period.

Total Cost for Manure Spreading for This System, Study Period and Estimated Annual Cost: The total cost of all expenses and activities for the manure that was applied during the study period. The total amount spent on spreading manure in a similar manner for the year is estimated by dividing the total cost for the study period by the percent of the estimated total manure for the year that was captured during the study period.

Worker Equivalent: The number of full-time workers that would be equivalent to all the full and part-time people working throughout the year. Operator and family labor is included. Worker equivalents are determined by converting all work to full-time months (based on 230 hours per month) and dividing by 12.

OTHER A.E.M. EXTENSION BULLETINS

EB No	Title	Fee (if applicable)	Author(s)
2014-11	Cost of Establishment and Production of Hybrid Grapes in the Finger Lakes Region of New York, 2013		Tang, Y., Gómez, M. and G. White
2014-10	New York Economic Handbook, 2015	(\$10.00)	Extension Staff
2014-09	Dairy Farm Business Summary, Northern New York Region, 2013	(\$12.00)	Knoblauch, W., Dymond, C., Karszes, J., Howland, B., Murray, P., Deming, A., Balbain, D., Buxton, S., Manning, J., Collins, B. and A. Figueras
2014-08	Dairy Farm Business Summary, Hudson and Central New York Region, 2013	(\$12.00)	Knoblauch, W., Conneman, G., Dymond, C., Karszes, J. Howland, B., Buxton, S., Kiraly, M., Kimmich, R. and K. Shoen
2014-07	Dairy Farm Business Summary, New York Small Herd Farms, 140 Cows or Fewer, 2013	(\$16.00)	Knoblauch, W., Dymond, C., Karszes, J. and M. Kiraly
2014-06	Dairy Farm Business Summary, Western New York Region, 2013	(\$12.00)	Knoblauch, W., Dymond, C., Karszes, J., Howland, B., Hanchar, J., Carlberg, V., Kimmich, R. and J. Petzen
2014-05	Dairy Farm Business Summary, New York Large Herd Farms, 300 Cows or Larger, 2013	(\$16.00)	Karszes, J., Knoblauch, W. and C. Dymond
2014-04	Agriculture-Based Economic Development in New York State: The Contribution of Agriculture to the New York Economy		Schmit, T.
2014-03	Agriculture-Based Economic Development in New York State: Assessing the Inner-Industry Linkages in the Agricultural and Food System		Schmit, T. and R. Boisvert
2014-02	Dairy Replacement Programs: Cost & Analysis 3rd Quarter 2012		Karszes, J.

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